(scattering by material contents), cloudshine (scattering by air), and groundshine (scattering by the ground). Credit for potential shielding between the shipment and the receptor was not considered.

The RISKIND code was also used to provide a scenario-specific assessment of radiological consequences of severe transportation-related accidents. Whereas the RADTRAN 5 risk assessment considers the entire range of accident severities and their related probabilities, the RISKIND consequence assessment focuses on accident scenarios that result in the largest releases of radioactive material to the environment that are reasonably foreseeable. The consequence assessment was intended to provide an estimate of the potential impacts posed by a severe, but highly unlikely, transportation-related accident scenario.

The dose to each maximally exposed individual considered was calculated with RISKIND for an exposure scenario defined by a given distance, duration, and frequency of exposure specific to that receptor. The distances and durations were similar to those given in previous transportation risk assessments. The scenarios were not meant to be exhaustive but were selected to provide a range of potential exposure situations.

### J.1.2 NUMBER AND ROUTING OF SHIPMENTS

This section discusses the number of shipments and routing information used to analyze potential impacts that would result from preparation for and conduct of transportation operations to ship spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site. Table J-1 summarizes the estimated numbers of shipments for the various inventory and national shipment scenario combinations.

#### J.1.2.1 Number of Shipments

DOE used two analysis scenarios—mostly legal-weight truck and mostly train (rail)—as bases for estimating the number of shipments of spent nuclear fuel and high-level radioactive waste from 72 commercial and 5 DOE sites. The number of shipments for the scenarios was used in analyzing transportation impacts for the Proposed Action and Inventory Modules 1 and 2. DOE selected the scenarios because, more than 10 years before the projected start of operations at the repository, it cannot accurately predict the actual mix of rail and legal-weight truck transportation that would occur from the 77 sites to the repository. Therefore, the selected scenarios enable the analysis to bound (or bracket) the ranges of legal-weight truck and rail shipments that could occur.

The analysis estimated the number of shipments from commercial sites where spent nuclear fuel would be loaded and shipped and from DOE sites where spent nuclear fuel, naval spent nuclear fuel, and high-level radioactive waste would be loaded and shipped.

For the mostly legal-weight truck scenario, with one exception, shipments were assumed to use legal-weight trucks. Overweight, overdimensional trucks weighing between about 36,300 and 52,200 kilograms (80,000 and 115,000 pounds) but otherwise similar to legal-weight trucks could be used for some spent nuclear fuel and high-level radioactive waste (for example, spent nuclear fuel from the South Texas reactors). The exception that gives the scenario its name—mostly legal-weight truck—was for shipments of naval spent nuclear fuel. Under this scenario, naval spent nuclear fuel would be shipped by rail, as decided in the *Record of Decision for a Dry Storage Container System for the Management of Naval Spent Nuclear Fuel* (62 *FR* 1095; January 8, 1997).

For the mostly rail scenario, the analysis assumed that all sites would ship by rail, with the exception of those with physical limitations that would make rail shipment impractical. The exception would be for shipments by legal-weight trucks from six commercial sites that do not have the capability to load rail casks. However, the analysis also assumed that these six sites would be upgraded to handle a rail cask after the reactors were shut down and would ship either by direct rail or by heavy-haul truck or barge to

**Table J-1.** Summary of estimated number of shipments for the various inventory and national transportation analysis scenario combinations.

| | Mostly truck | | Mostly rail | |
|---|---|---|---|---|
| | Truck | Rail | Truck | Rail |
| *Proposed Action* | | | | |
| Commercial spent nuclear fuel | 41,001 | 0 | 1,079 | 7,218 |
| High-level radioactive waste | 8,315 | 0 | 0 | 1,663 |
| DOE spent nuclear fuel | 3,470 | 300 | 0 | 765 |
| Greater-Than-Class-C waste | 0 | 0 | 0 | 0 |
| Special-Performance-Assessment-Required waste | 0 | 0 | 0 | 0 |
| *Proposed Action totals* | *52,786* | *300* | *1,079* | *9,646* |
| *Module 1*[a] | | | | |
| Commercial spent nuclear fuel | 79,684 | 0 | 3,122 | 12,989 |
| High-level radioactive waste | 22,280 | 0 | 0 | 4,458 |
| DOE spent nuclear fuel | 3,721 | 300 | 0 | 796 |
| Greater-Than-Class-C waste | 0 | 0 | 0 | 0 |
| Special-Performance-Assessment-Required waste | 0 | 0 | 0 | 0 |
| *Module 1 totals* | *105,685* | *300* | *3,122* | *18,243* |
| *Module 2*[a] | | | | |
| Commercial spent nuclear fuel | 79,684 | 0 | 3,122 | 12,989 |
| High-level radioactive waste | 22,280 | 0 | 0 | 4,458 |
| DOE spent nuclear fuel | 3,721 | 300 | 0 | 796 |
| Greater-Than-Class-C waste | 1,096 | 0 | 0 | 282 |
| Special-Performance-Assessment-Required waste | 1,763 | 55 | 0 | 410 |
| *Module 2 totals* | *108,544* | *355* | *3,122* | *18,935* |

a. The number of shipments for Module 1 includes all shipments of spent nuclear fuel and high-level radioactive waste included in the Proposed Action and shipments of additional spent nuclear fuel and high-level radioactive waste as described in Appendix A. The number of shipments for Module 2 includes all the shipments in Module 1 and additional shipments of highly radioactive materials described in Appendix A.

nearby railheads. Of these six sites, two are direct rail sites and four are indirect rail sites. Of the four indirect rail sites, three are adjacent to navigable waterways and could ship by barge. In addition, under this scenario, the analysis assumed that 24 commercial sites that do not have direct rail service but that could handle large casks would ship by barge or heavy-haul truck to nearby railheads with intermodal capability.

For commercial spent nuclear fuel, the CALVIN code was used to compute the number of shipments. The number of shipments of DOE spent nuclear fuel and high-level radioactive waste was estimated based on the data in Appendix A and information provided by the DOE sites. The numbers of shipments were estimated based on the characteristics of the materials shipped, mode interface capability (for example, the lift capacity of the cask-handling crane) of each shipping facility, and the modal-mix case analyzed. Table J-2 summarizes the basis for the national and Nevada transportation impact analysis.

Detailed descriptions of spent nuclear fuel and high-level radioactive waste that would be shipped to the Yucca Mountain site are presented in Appendix A.

#### J.1.2.1.1 *Commercial Spent Nuclear Fuel*

For the analysis, the CALVIN model used 31 shipping cask configurations: 9 for legal-weight truck casks (Figure J-3) and 22 for rail casks (Figure J-4). Table J-3 lists the legal-weight truck and rail cask configurations used in the analysis and their capacities. The analysis assumed that all shipments would use one of the 31 configurations. If the characteristics of the spent nuclear fuel projected for shipment

**Table J-2.** Analysis basis—national and Nevada transportation scenarios.[a,b]

| Material | Mostly legal-weight truck scenario national and Nevada | National mostly rail scenario: Nevada rail scenario | National mostly rail scenario: Nevada heavy-haul truck scenario |
|---|---|---|---|
| *Casks* | | | |
| Commercial SNF | Truck casks – about 1.8 MTHM per cask | Rail casks – 6 to 12 MTHM per cask for shipments from 66 sites | Rail casks – 6 to 12 MTHM per cask for shipments from 66 sites |
| | | Truck casks – about 1.8 MTHM per cask for shipments from 6 sites[c] | Truck casks – about 1.8 MTHM per cask for shipments from 6 sites |
| DOE HLW and DOE SNF, except naval SNF | Truck casks – 1 SNF or HLW canister per cask | Rail casks – four to nine SNF or HLW canisters per cask | Rail casks – four to nine SNF or HLW canisters per cask |
| Naval SNF | Disposal canisters in large rail casks for shipment from INEEL | Disposable canisters in large rail casks for shipments from INEEL | Disposable canisters in large rail casks for shipments from INEEL |
| *Transportation modes* | | | |
| Commercial SNF | Legal-weight trucks | Direct rail from 49 sites served by railroads to repository | Rail from 49 sites served by railroads to intermodal transfer station in Nevada, then heavy-haul trucks to repository |
| | | Heavy-haul trucks from 7 sites to railhead, then rail to repository | Heavy-haul trucks from 7 sites to railheads, then rail to intermodal transfer station in Nevada, then heavy-haul trucks to repository |
| | | Heavy-haul trucks or barges[d] from 17 sites to railhead, then rail to repository | Heavy-haul trucks or barges[d] from 17 sites to railheads, then rail to intermodal transfer station in Nevada, then heavy-haul trucks to repository |
| | | Legal-weight trucks from 6 sites to repository[c] | Legal-weight trucks from 6 sites to repository[c] |
| DOE HLW and DOE SNF, except naval SNF | Legal-weight trucks | Rail from DOE sites[e] to repository | Rail from DOE sites[e] to intermodal transfer station in Nevada, then heavy-haul trucks to repository |
| Naval SNF | Rail from INEEL to intermodal transfer station in Nevada, then heavy-haul trucks to repository | Rail from INEEL to repository | Rail from INEEL to intermodal transfer station in Nevada, then heavy-haul trucks to repository |

a. Abbreviations: SNF = spent nuclear fuel; MTHM = metric tons of heavy metal; HLW = high-level radioactive waste; INEEL = Idaho National Engineering and Environmental Laboratory.

b. G. E. Morris facility is included with the Dresden reactor facilities in the 72 commercial sites.

c. The analysis assumed that the six legal-weight truck sites would upgrade their crane capacity upon reactor shutdown and would ship all remaining spent nuclear fuel by rail. Of those six sites, four are heavy-haul sites and two are direct rail sites. Three of the heavy-haul sites have barge capability (Pilgrim, St. Lucie 1, and Indian Point).

d. Seventeen of 24 commercial sites not served by a railroad are on or near a navigable waterway. Some of these 17 sites could ship by barge rather than by heavy-haul truck to a nearby railhead. Salem/Hope Creek treated as two sites for heavy-haul or barge analysis.

e. Hanford Site, Savannah River Site, Idaho National Engineering and Environmental Laboratory, West Valley Demonstration Project, and Ft. St. Vrain.

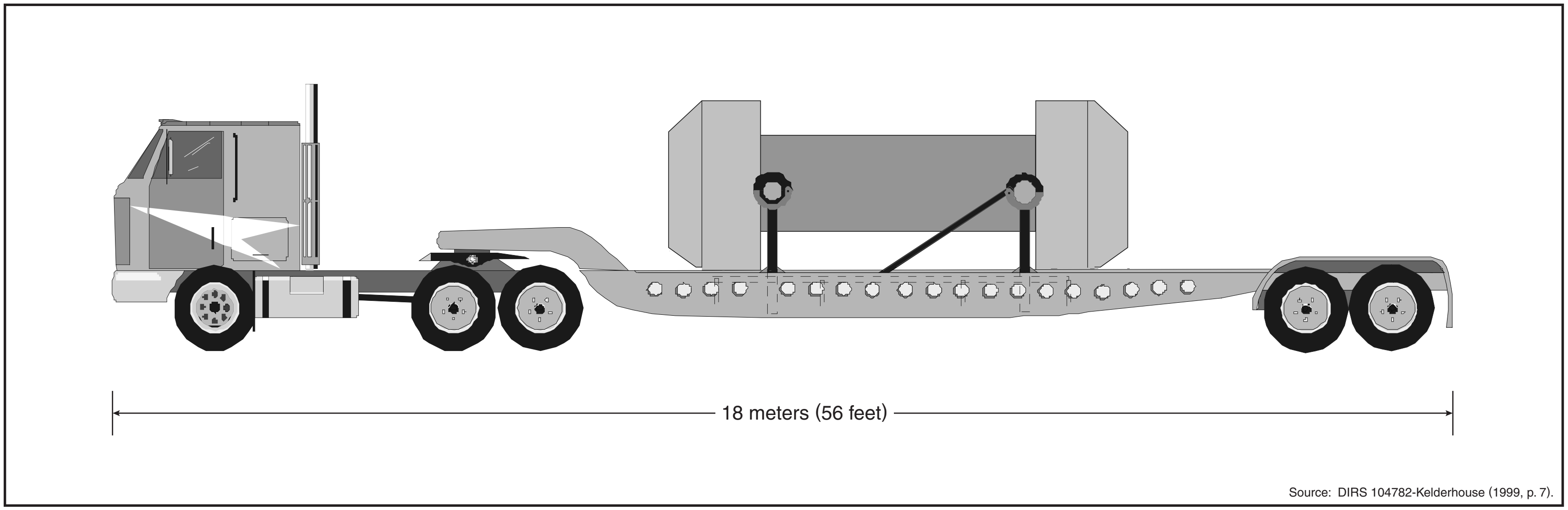


**Figure J-3.** Artist's conception of a truck cask on a legal-weight tractor-trailer truck.

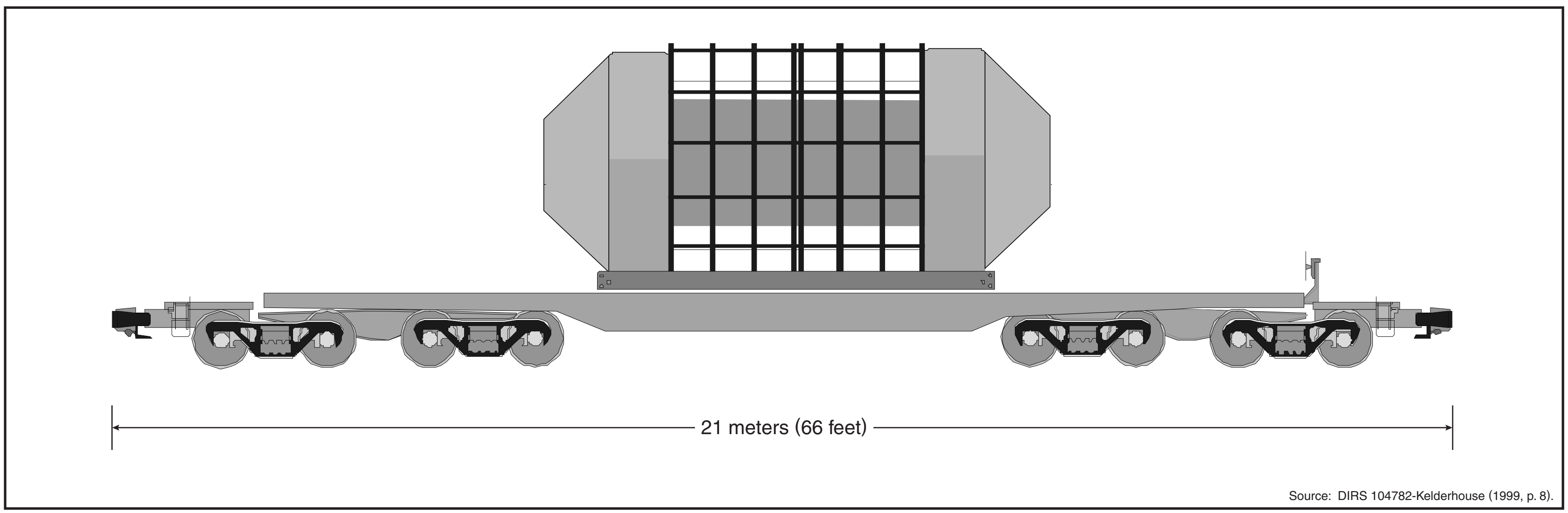


**Figure J-4.** Artist's conception of a large rail cask on a railcar.

**Table J-3.** Shipping cask configurations.

| Shipping cask | Capacity (number of spent nuclear fuel assemblies) | Description[a,b] |
|---|---|---|
| *Rail* | | |
| B-R-32-SP | 32 | BWR single-purpose shipping container |
| B-R-32-SP-HH | 32 | BWR single-purpose high-heat-capacity shipping container |
| B-R-44-SP | 44 | Medium BWR single-purpose shipping container |
| B-R-68-OV | 68 | Large BWR overpack shipping container |
| B-R-68-SP | 68 | Large BWR single-purpose shipping container |
| B-R-BP64-OV | 64 | Plant-unique overpack shipping container |
| B-R-HI68-OV | 68 | BWR HISTAR overpack shipping container |
| B-R-NAC56-OV | 56 | BWR NAC UMS overpack shipping container |
| P-R-12-SP | 12 | Small PWR single-purpose shipping container |
| P-R-12-SP-HH | 12 | Small PWR single-purpose high-heat-capacity shipping container |
| P-R-21-SP | 21 | Medium PWR single-purpose shipping container |
| P-R-24-OV | 24 | Large PWR overpack shipping container |
| P-R-24-SP | 24 | Large PWR single-purpose shipping container |
| P-R-7-SP-HH | 7 | PWR high heat shipping container |
| P-R-9-OV-MOX | 9 | PWR mixed-oxide overpack shipping container |
| P-R-9-SP-MOX | 9 | PWR mixed-oxide single-purpose shipping container |
| P-R-MP24-OV | 24 | PWR MP-187 (large) overpack shipping container |
| P-R-NAC26-OV | 26 | PWR NAC UMS overpack shipping container |
| P-R-ST17-SP | 17 | PWR plant-unique single-purpose shipping container |
| P-R-VSC24-OV | 24 | PWR Transtor ventilated storage cask overpack shipping container |
| P-R-WES21-OV | 21 | PWR WESFLEX overpack shipping container |
| P-R-YR36-OV | 36 | PWR plant-unique overpack shipping container |
| *Truck* | | |
| B-T-9/9-SP | 9 | BWR single-purpose shipping container |
| B-T-9/7-SP | 7 | Derated BWR single-purpose shipping container |
| P-T-4/4-SP | 4 | Primary PWR single-purpose shipping container |
| P-T-4/3-SP | 3 | Derated PWR single-purpose shipping container |
| P-T-4/2-SP | 2 | Derated PWR single-purpose shipping container |
| P-T-4/4-SP-ST | 4 | PWR plant-unique single-purpose shipping container |
| P-T-4/3-SP-ST | 3 | PWR Derated plant-unique single-purpose shipping container |
| P-T-4/4-SP-MOX | 4 | PWR Mixed-oxide single-purpose shipping container |
| P-T-4/4-SP-BP | 1 | PWR plant-unique single-purpose shipping container |

a. Source: DIRS 157206-CRWMS M&O (2000, all).
b. BWR = boiling-water reactor; PWR = pressurized-water reactor; SNF = spent nuclear fuel.

exceeded the capabilities of one of the casks, the model reduced the cask's capacity for the affected shipments. The reduction, which is sometimes referred to as cask derating, was needed to satisfy nuclear criticality, shielding, and thermal constraints. For shipments that DOE would make using specific casks, derating would be accomplished by partially filling the assigned casks in compliance with provisions of applicable Nuclear Regulatory Commission certificates of compliance. An example of derating is discussed in Section 5 of the GA-4 legal-weight truck shipping cask design report (DIRS 101831-General Atomics 1993, p. 5.5-1). The analysis addresses transport of two high-burnup or short cooling time pressurized-water reactor assemblies rather than four design basis assemblies.

**RAIL SHIPMENTS**

This appendix assumes that rail shipments of spent nuclear fuel would use large rail shipping casks, one per railcar. DOE anticipates that as many as five railcars with casks containing spent nuclear fuel or high-level radioactive waste would move together in individual trains with buffer cars and escort cars. For general freight service, a train would include other railcars with other materials. In dedicated (or special) service, trains would move only railcars containing spent nuclear fuel or high-level radioactive waste and the buffer and escort cars.

For the mostly rail scenario, six sites without sufficient crane capacity to lift a rail cask or without other factors such as sufficient floor loading capacity or ceiling height were assumed to ship by legal-weight truck. However, the analysis assumed that these sites would be upgraded to handle rail casks once the reactors were shut down, and all remaining spent nuclear fuel would ship by rail. Of these six sites, two are direct rail and four are indirect rail sites. Of the four with indirect rail access, three have access to a navigable waterway. The 24 sites with sufficient crane capacity but without direct rail access were assumed to ship by heavy-haul truck to the nearest railhead. Of these 24 sites, 17 with access to navigable waterways were analyzed for shipping by barge to a railhead (see Section J.2.4). The number of rail shipments (direct or indirect) was estimated based on each site using the largest cask size feasible based on the load capacity of its cask handling crane. In calculating the number of shipments from the sites, the model used the *Acceptance, Priority Ranking & Annual Capacity Report* (DIRS 104382-DOE 1995, all). Using CALVIN, the number of shipments of legal-weight truck casks (Figure J-3) of commercial spent nuclear fuel estimated for the Proposed Action (63,000 MTHM of commercial spent nuclear fuel) for the mostly legal-weight truck scenario, would be about 15,000 containing boiling-water reactor assemblies and 26,000 containing pressurized-water reactor assemblies. Under Inventory Modules 1 and 2, for which approximately 105,000 MTHM of commercial spent nuclear fuel would be shipped to the repository (see Appendix A), the estimated number of shipments for the mostly legal-weight truck scenario would be 29,000 for boiling-water reactor spent nuclear fuel and 51,000 for pressurized-water reactor spent nuclear fuel. Table J-4 lists the number of shipments of commercial spent nuclear fuel for the mostly legal-weight truck scenario. Specifically, it lists the site, plant, and state where shipments would originate, the total number of shipments from each site, and the type of spent nuclear fuel that would be shipped. A total of 72 commercial sites with 104 plants (or facilities) are listed in the table.

The number of shipments of truck and rail casks (Figure J-4) of commercial spent nuclear fuel estimated for the Proposed Action for the mostly rail scenario would be approximately 2,700 for boiling-water reactor spent nuclear fuel and 5,600 for pressurized-water reactor spent nuclear fuel. Under Modules 1 and 2, the estimated number of shipments for the mostly rail scenario would be approximately 5,400 containing boiling-water reactor spent nuclear fuel and 10,700 containing pressurized-water reactor spent nuclear fuel. Table J-5 lists the number of shipments for the mostly rail scenario. It also lists the site and state where shipments would originate, the total number of shipments from each site, the size of rail cask assumed for each site, and the type of spent nuclear fuel that would be shipped. In addition, it lists the 24 sites not served by a railroad that would ship rail casks by barge or heavy-haul trucks to a nearby railhead and the 6 commercial sites without capability to load a rail cask.

#### J.1.2.1.2 *DOE Spent Nuclear Fuel and High-Level Radioactive Waste*

To estimate the number of DOE spent nuclear fuel and high-level radioactive waste shipments, the analysis used the number of handling units or number of canisters and the number of canisters per shipment reported by the DOE sites in 1998 (see Appendix A, p. A-34; DIRS 104778-Jensen 1998, all). To determine the number of shipments of DOE spent nuclear fuel and high-level radioactive waste, the analysis assumed one canister would be shipped in a legal-weight truck cask. For rail shipments, the analysis assumed that five 61-centimeter (24-inch)-diameter high-level radioactive waste canisters would be shipped in a rail cask. For rail shipments of DOE spent nuclear fuel, the analysis assumed that rail casks would contain nine approximately 46-centimeter (18-inch) canisters or four approximately 61-centimeter canisters. The number of DOE spent nuclear fuel canisters of each size is presented in Appendix A.

Under the mostly legal-weight truck scenario for the Proposed Action, DOE would transport a total of 11,785 truck shipments of DOE spent nuclear fuel and high-level radioactive waste (one high-level waste canister per shipment) to the repository. In addition, DOE would transport 300 shipments of naval spent nuclear fuel by rail from the Idaho National Engineering and Environmental Laboratory to the repository

**Table J-4.** Shipments of commercial spent nuclear fuel, mostly legal-weight truck scenario[a] (page 1 of 2).

| Site | Reactor | State | Fuel type | Proposed Action (2010-2033) | Modules 1 and 2 (2010-2048) |
|---|---|---|---|---|---|
| Browns Ferry | Browns Ferry 1 | AL | B[b] | 738 | 1,550 |
| | Browns Ferry 3 | AL | B | 324 | 807 |
| Joseph M. Farley | Joseph M. Farley 1 | AL | P[c] | 363 | 779 |
| | Joseph M. Farley 2 | AL | P | 330 | 843 |
| Arkansas Nuclear One | Arkansas Nuclear One, Unit 1 | AR | P | 362 | 645 |
| | Arkansas Nuclear One, Unit 2 | AR | P | 432 | 905 |
| Palo Verde | Palo Verde 1 | AZ | P | 383 | 694 |
| | Palo Verde 2 | AZ | P | 375 | 691 |
| | Palo Verde 3 | AZ | P | 360 | 716 |
| Diablo Canyon | Diablo Canyon 1 | CA | P | 359 | 971 |
| | Diablo Canyon 2 | CA | P | 370 | 1,130 |
| Humboldt Bay | Humboldt Bay | CA | B | 44 | 44 |
| Rancho Seco | Rancho Seco 1 | CA | P | 124 | 124 |
| San Onofre | San Onofre 1 | CA | P | 52 | 52 |
| | San Onofre 2 | CA | P | 408 | 817 |
| | San Onofre 3 | CA | P | 393 | 829 |
| Haddam Neck | Haddam Neck | CT | P | 255 | 255 |
| Millstone | Millstone 1 | CT | B | 321 | 321 |
| | Millstone 2 | CT | P | 361 | 694 |
| | Millstone 3 | CT | P | 310 | 1,008 |
| Crystal River | Crystal River 3 | FL | P | 277 | 621 |
| St. Lucie | St. Lucie 1 | FL | P | 426 | 849 |
| | St. Lucie 2 | FL | P | 380 | 987 |
| Turkey Point | Turkey Point 3 | FL | P | 291 | 574 |
| | Turkey Point 4 | FL | P | 292 | 570 |
| Edwin I. Hatch | Edwin I. Hatch 1 | GA | B | 939 | 1,820 |
| Vogtle | Vogtle 1 | GA | P | 725 | 1,379 |
| Duane Arnold | Duane Arnold | IA | B | 324 | 576 |
| Braidwood | Braidwood 1 | IL | P | 565 | 1,142 |
| Byron | Byron 1 | IL | P | 617 | 1,136 |
| Clinton | Clinton 1 | IL | B | 363 | 636 |
| Dresden/Morris | Dresden 1 | IL | B | 76 | 76 |
| | Dresden 2 | IL | B | 459 | 726 |
| | Dresden 3 | IL | B | 514 | 760 |
| | Morris[d] | IL | B | 319 | 319 |
| | Morris[d] | IL | P | 88 | 88 |
| LaSalle | LaSalle 1 | IL | B | 769 | 2,080 |
| Quad Cities | Quad Cities 1 | IL | B | 979 | 1,567 |
| Zion | Zion 1 | IL | P | 557 | 557 |
| Wolf Creek | Wolf Creek 1 | KS | P | 396 | 678 |
| River Bend | River Bend 1 | LA | B | 353 | 636 |
| Waterford | Waterford 3 | LA | P | 374 | 607 |
| Pilgrim | Pilgrim 1 | MA | B | 322 | 575 |
| Yankee-Rowe | Yankee-Rowe 1 | MA | P | 134 | 134 |
| Calvert Cliffs | Calvert Cliffs 1 | MD | P | 867 | 1,612 |
| Maine Yankee | Maine Yankee | ME | P | 356 | 356 |
| Big Rock Point | Big Rock Point | MI | B | 110 | 111 |
| D. C. Cook | D. C. Cook 1 | MI | P | 832 | 1,759 |
| Fermi | Fermi 2 | MI | B | 377 | 662 |
| Palisades | Palisades | MI | P | 409 | 660 |
| Monticello | Monticello | MN | B | 257 | 435 |
| Prairie Island | Prairie Island 1 | MN | P | 665 | 1,109 |
| Callaway | Callaway 1 | MO | P | 435 | 701 |
| Grand Gulf | Grand Gulf 1 | MS | B | 592 | 1,383 |
| Brunswick | Brunswick 1 | NC | P | 40 | 40 |
| | Brunswick 2 | NC | P | 36 | 36 |
| | Brunswick 1 | NC | B | 281 | 702 |
| | Brunswick 2 | NC | B | 282 | 657 |

**Table J-4.** Shipments of commercial spent nuclear fuel, mostly legal-weight truck scenario[a] (page 2 of 2).

| Site | Reactor | State | Fuel type | Proposed Action (2010-2033) | Modules 1 and 2 (2010-2048) |
|---|---|---|---|---|---|
| Shearon Harris | Shearon Harris 1 | NC | P | 289 | 549 |
| | Shearon Harris | NC | B | 152 | 152 |
| McGuire | McGuire 1 | NC | P | 372 | 932 |
| | McGuire 2 | NC | P | 419 | 1,069 |
| Cooper Station | Cooper Station | NE | B | 272 | 621 |
| Fort Calhoun | Fort Calhoun | NE | P | 260 | 457 |
| Seabrook | Seabrook 1 | NH | P | 277 | 590 |
| Oyster Creek | Oyster Creek 1 | NJ | B | 451 | 658 |
| Salem/Hope Creek | Salem 1 | NJ | P | 329 | 725 |
| | Salem 2 | NJ | P | 304 | 826 |
| | Hope Creek | NJ | B | 444 | 796 |
| James A. FitzPatrick/ Nine Mile Point | James A. FitzPatrick | NY | B | 413 | 732 |
| | Nine Mile Point 1 | NY | B | 426 | 628 |
| | Nine Mile Point 2 | NY | B | 387 | 722 |
| Ginna | Ginna | NY | P | 320 | 472 |
| Indian Point | Indian Point 1 | NY | P | 40 | 40 |
| | Indian Point 2 | NY | P | 400 | 805 |
| | Indian Point 3 | NY | P | 285 | 694 |
| Davis-Besse | Davis-Besse 1 | OH | P | 343 | 786 |
| Perry | Perry 1 | OH | B | 293 | 528 |
| Trojan | Trojan | OR | P | 195 | 195 |
| Beaver Valley | Beaver Valley 1 | PA | P | 309 | 649 |
| | Beaver Valley 2 | PA | P | 248 | 472 |
| Limerick | Limerick 1 | PA | B | 740 | 1,354 |
| Peach Bottom | Peach Bottom 2 | PA | B | 567 | 1,023 |
| | Peach Bottom 3 | PA | B | 575 | 1,035 |
| Susquehanna | Susquehanna 1 | PA | B | 1,044 | 2,482 |
| Three Mile Island | Three Mile Island 1 | PA | P | 320 | 654 |
| Catawba | Catawba 1 | SC | P | 327 | 555 |
| | Catawba 2 | SC | P | 310 | 574 |
| Oconee | Oconee 1 | SC | P | 970 | 1,668 |
| | Oconee 3 | SC | P | 324 | 666 |
| H. B. Robinson | H. B. Robinson 2 | SC | P | 249 | 470 |
| Summer | Summer 1 | SC | P | 281 | 713 |
| Sequoyah | Sequoyah | TN | P | 644 | 1,768 |
| Watts Bar | Watts Bar 1 | TN | P | 158 | 552 |
| Comanche Peak | Comanche Peak 1 | TX | P | 665 | 1,409 |
| South Texas | South Texas 1 | TX | P | 271 | 614 |
| | South Texas 2 | TX | P | 257 | 590 |
| North Anna | North Anna 1 | VA | P | 675 | 1,588 |
| Surry | Surry 1 | VA | P | 863 | 1,457 |
| Vermont Yankee | Vermont Yankee 1 | VT | B | 380 | 613 |
| Columbia Generating Station | Columbia Generating Station | WA | B | 415 | 1,006 |
| Kewaunee | Kewaunee | WI | P | 306 | 516 |
| LaCrosse | LaCrosse | WI | B | 37 | 37 |
| Point Beach | Point Beach | WI | P | 653 | 1,051 |
| Total BWR[b] | | | | 15,229 | 28,719 |
| Total PWR[c] | | | | 25,772 | 50,965 |

a. Source: DIRS 157206-CRWMS M&O (2000, all).
b. B = boiling-water reactor (BWR).
c. P = pressurized-water reactor (PWR).
d. Morris is a storage facility located close to the three Dresden reactors.

**Table J-5.** Shipments of commercial spent nuclear fuel, mostly rail scenario[a] (page 1 of 2).

| Site | Reactor | State | Fuel type | Cask | Proposed Action 2010 - 2033 | Modules 1 and 2 2010 - 2048 |
|---|---|---|---|---|---|---|
| Browns Ferry | Browns Ferry 1 | AL | B[b] | Rail | 122 | 247 |
| | Browns Ferry 3 | AL | B | Rail | 51 | 120 |
| Joseph M. Farley | Joseph M. Farley 1 | AL | P[c] | Rail | 57 | 132 |
| | Joseph M. Farley 2 | AL | P | Rail | 53 | 131 |
| Arkansas Nuclear One | Arkansas Nuclear One, Unit 1 | AR | P | Rail | 57 | 108 |
| | Arkansas Nuclear One, Unit 2 | AR | P | Rail | 64 | 149 |
| Palo Verde | Palo Verde 1 | AZ | P | Rail | 65 | 97 |
| | Palo Verde 2 | AZ | P | Rail | 62 | 94 |
| | Palo Verde 3 | AZ | P | Rail | 66 | 102 |
| Diablo Canyon | Diablo Canyon 1 | CA | P | Rail | 60 | 148 |
| | Diablo Canyon 2 | CA | P | Rail | 61 | 160 |
| Humboldt Bay | Humboldt Bay | CA | B | Rail | 6 | 6 |
| Rancho Seco | Rancho Seco 1 | CA | P | Rail | 21 | 21 |
| San Onofre | San Onofre 1 | CA | P | Rail | 9 | 9 |
| | San Onofre 2 | CA | P | Rail | 65 | 131 |
| | San Onofre 3 | CA | P | Rail | 64 | 137 |
| Haddam Neck | Haddam Neck | CT | P | Rail | 40 | 40 |
| Millstone | Millstone 1 | CT | B | Rail | 91 | 91 |
| | Millstone 2 | CT | P | Rail | 115 | 199 |
| | Millstone 3 | CT | P | Rail | 49 | 138 |
| Crystal River | Crystal River 3 | FL | P | Rail | 25 | 17 |
| Crystal River | Crystal River 3 | FL | P | Truck | 133 | 437 |
| St Lucie | St. Lucie 1 | FL | P | Rail | 12 | 13 |
| St. Lucie | St. Lucie 1 | FL | P | Truck | 358 | 751 |
| | St. Lucie 2 | FL | P | Rail | 61 | 147 |
| Turkey Point | Turkey Point 3 | FL | P | Rail | 52 | 85 |
| | Turkey Point 4 | FL | P | Rail | 52 | 86 |
| Edwin I. Hatch | Edwin I. Hatch 1 | GA | B | Rail | 116 | 288 |
| Vogtle | Vogtle 1 | GA | P | Rail | 205 | 283 |
| Duane Arnold | Duane Arnold | IA | B | Rail | 57 | 129 |
| Braidwood | Braidwood 1 | IL | P | Rail | 94 | 162 |
| Byron | Byron 1 | IL | P | Rail | 101 | 159 |
| Clinton | Clinton 1 | IL | B | Rail | 59 | 87 |
| Dresden/Morris | Dresden 1 | IL | B | Rail | 11 | 11 |
| | Dresden 2 | IL | B | Rail | 83 | 158 |
| | Dresden 3 | IL | B | Rail | 89 | 160 |
| | Morris[d] | IL | B | Rail | 43 | 43 |
| | Morris[d] | IL | P | Rail | 15 | 15 |
| LaSalle | LaSalle 1 | IL | B | Rail | 101 | 305 |
| Quad Cities | Quad Cities 1 | IL | B | Rail | 172 | 329 |
| Zion | Zion 1 | IL | P | Rail | 93 | 93 |
| Wolf Creek | Wolf Creek 1 | KS | P | Rail | 63 | 97 |
| River Bend | River Bend 1 | LA | B | Rail | 57 | 87 |
| Waterford | Waterford 3 | LA | P | Rail | 66 | 93 |
| Pilgrim | Pilgrim 1 | MA | B | Rail | 24 | 18 |
| Pilgrim | Pilgrim 1 | MA | B | Truck | 154 | 394 |
| Yankee-Rowe | Yankee-Rowe 1 | MA | P | Rail | 15 | 15 |
| Calvert Cliffs | Calvert Cliffs 1 | MD | P | Rail | 169 | 320 |
| Maine Yankee | Maine Yankee | ME | P | Rail | 55 | 55 |
| Big Rock Point | Big Rock Point | MI | B | Rail | 7 | 7 |
| D. C. Cook | D. C. Cook 1 | MI | P | Rail | 149 | 268 |
| Fermi | Fermi 2 | MI | B | Rail | 61 | 91 |
| Palisades | Palisades | MI | P | Rail | 70 | 122 |
| Monticello | Monticello | MN | B | Rail | 32 | 19 |
| Monticello | Monticello | MN | B | Truck | 8 | 250 |
| Prairie Island | Prairie Island 1 | MN | P | Rail | 103 | 205 |
| Callaway | Callaway 1 | MO | P | Rail | 71 | 101 |
| Grand Gulf | Grand Gulf 1 | MS | B | Rail | 80 | 215 |

**Table J-5.** Shipments of commercial spent nuclear fuel, mostly rail scenario[a] (page 2 of 2).

| Site | Reactor | State | Fuel type | Cask | Proposed Action 2010 - 2033 | Modules 1 and 2 2010 - 2048 |
|---|---|---|---|---|---|---|
| Brunswick | Brunswick 1 | NC | P[c] | Rail | 14 | 14 |
| | Brunswick 2 | NC | P | Rail | 12 | 12 |
| | Brunswick 1 | NC | B[b] | Rail | 78 | 142 |
| | Brunswick 2 | NC | B | Rail | 78 | 140 |
| Shearon Harris | Shearon Harris 1 | NC | P | Rail | 89 | 146 |
| | Shearon Harris | NC | B | Rail | 43 | 43 |
| McGuire | McGuire 1 | NC | P | Rail | 83 | 164 |
| | McGuire 2 | NC | P | Rail | 89 | 173 |
| Cooper Station | Cooper Station | NE | B | Rail | 42 | 124 |
| Fort Calhoun | Fort Calhoun | NE | P | Rail | 61 | 120 |
| Seabrook | Seabrook 1 | NH | P | Rail | 49 | 80 |
| Oyster Creek | Oyster Creek 1 | NJ | B | Rail | 64 | 110 |
| Salem/Hope Creek | Salem 1 | NJ | P | Rail | 59 | 101 |
| | Salem 2 | NJ | P | Rail | 54 | 108 |
| | Hope Creek | NJ | B | Rail | 67 | 105 |
| James A. FitzPatrick/ | FitzPatrick | NY | B | Rail | 60 | 121 |
| Nine Mile Point | Nine Mile Point 1 | NY | B | Rail | 72 | 99 |
| | Nine Mile Point 2 | NY | B | Rail | 65 | 105 |
| Ginna | Ginna | NY | P | Rail | 36 | 22 |
| Ginna | Ginna | NY | P | Truck | 91 | 297 |
| Indian Point | Indian Point 1 | NY | P | Truck | 40 | 40 |
| | Indian Point 2 | NY | P | Rail | 35 | 34 |
| | Indian Point 2 | NY | P | Truck | 150 | 471 |
| | Indian Point 3 | NY | P | Rail | 22 | 19 |
| | Indian Point 3 | NY | P | Truck | 145 | 482 |
| Davis-Besse | Davis-Besse 1 | OH | P | Rail | 64 | 140 |
| Perry | Perry 1 | OH | B | Rail | 42 | 67 |
| Trojan | Trojan | OR | P | Rail | 33 | 33 |
| Beaver Valley | Beaver Valley 1 | PA | P | Rail | 52 | 94 |
| | Beaver Valley 2 | PA | P | Rail | 41 | 76 |
| Limerick | Limerick 1 | PA | B | Rail | 148 | 216 |
| Peach Bottom | Peach Bottom 2 | PA | B | Rail | 82 | 157 |
| | Peach Bottom 3 | PA | B | Rail | 80 | 157 |
| Susquehanna | Susquehanna 1 | PA | B | Rail | 201 | 460 |
| Three Mile Island | Three Mile Island 1 | PA | P | Rail | 57 | 97 |
| Catawba | Catawba 1 | SC | P | Rail | 70 | 109 |
| | Catawba 2 | SC | P | Rail | 69 | 107 |
| Oconee | Oconee 1 | SC | P | Rail | 208 | 353 |
| | Oconee 3 | SC | P | Rail | 64 | 129 |
| H. B. Robinson | H. B. Robinson 2 | SC | P | Rail | 82 | 128 |
| Summer | Summer 1 | SC | P | Rail | 46 | 113 |
| Sequoyah | Sequoyah | TN | P | Rail | 95 | 275 |
| Watts Bar | Watts Bar 1 | TN | P | Rail | 26 | 74 |
| Comanche Peak | Comanche Peak 1 | TX | P | Rail | 154 | 250 |
| South Texas | South Texas 1 | TX | P | Rail | 58 | 104 |
| | South Texas 2 | TX | P | Rail | 57 | 105 |
| North Anna | North Anna 1 | VA | P | Rail | 143 | 289 |
| Surry | Surry 1 | VA | P | Rail | 197 | 330 |
| Vermont Yankee | Vermont Yankee 1 | VT | B | Rail | 73 | 137 |
| Columbia Generating Station | Columbia Generating Station | WA | B | Rail | 77 | 159 |
| Kewaunee | Kewaunee | WI | P | Rail | 51 | 87 |
| La Crosse | La Crosse | WI | B | Rail | 5 | 5 |
| Point Beach | Point Beach | WI | P | Rail | 130 | 213 |
| Total BWR[b] | | | | | 2,701 | 5,402 |
| Total PWR[c] | | | | | 5,596 | 10,709 |

a. Source: DIRS 157206-CRWMS M&O (2000, all).
b. B = boiling-water reactor (BWR).
c. P = pressurized-water reactor (PWR).
d. Morris is a storage facility located close to the three Dresden reactors.

(one naval spent nuclear fuel canister per rail cask). For Modules 1 and 2 under the mostly legal-weight truck scenario, the analysis estimated 26,001 DOE spent nuclear fuel and high-level radioactive waste truck shipments, as well as the 300 naval spent nuclear fuel shipments by rail.

Under the mostly rail scenario for the Proposed Action, the analysis estimated that DOE would transport 2,128 railcar shipments of DOE spent nuclear fuel and high-level radioactive waste (five high-level waste canisters per shipment), as well as the 300 shipments of naval spent nuclear fuel. For Modules 1 and 2 under this scenario, DOE would transport 4,954 railcar shipments of DOE spent nuclear fuel and high-level radioactive waste, as well as the 300 shipments of naval spent nuclear fuel. Table J-6 lists the estimated number of shipments of DOE and naval spent nuclear fuel from each of the sites for both the Proposed Action and Modules 1 and 2. Table J-7 lists the number of shipments of high-level radioactive waste for the Proposed Action and for Modules 1 and 2.

**Table J-6.** DOE and naval spent nuclear fuel shipments by site.

| | Proposed Action | | Module 1 or 2 | |
|---|---|---|---|---|
| Site | Mostly truck | Mostly rail | Mostly truck | Mostly rail |
| INEEL[a] | 1,388[b] | 433 | 1,467[c] | 442 |
| Savannah River Site | 1,316 | 149 | 1,411 | 159 |
| Hanford | 754 | 147 | 809 | 157 |
| Fort St. Vrain | 312 | 36 | 334 | 38 |
| ***Totals*** | ***3,770*** | ***765*** | ***4,021*** | ***796*** |

a. INEEL = Idaho National Engineering and Environmental Laboratory.
b. Includes 1,088 truck shipments of DOE spent nuclear fuel and 300 railcar shipments of naval spent nuclear fuel.
c. Includes 1,167 truck shipments of DOE spent nuclear fuel and 300 railcar shipments of naval spent nuclear fuel.

**Table J-7.** High-level radioactive waste shipments by site.[a]

| | Proposed Action | | Module 1 or 2 | |
|---|---|---|---|---|
| Site | Mostly truck[b] | Mostly rail[c] | Mostly truck[b] | Mostly rail[c] |
| INEEL[d] | 0 | 0 | 1,292 | 260[e] |
| Hanford | 1,960 | 392 | 14,500 | 2,900 |
| Savannah River Site | 6,055 | 1,211 | 6,188 | 1,238 |
| West Valley[f] | 300 | 60 | 300 | 60 |
| ***Totals*** | ***8,315*** | ***1,663*** | ***22,280*** | ***4,458*** |

a. The total U.S. inventory of high-level radioactive waste at the time of shipment would be 22,280 canisters. Under the Proposed Action, DOE would only ship 8,315 canisters. Under Inventory Module 1 or 2, DOE would ship the entire inventory.
b. One canister per shipment.
c. Five canisters per shipment.
d. INEEL = Idaho National Engineering and Environmental Laboratory.
e. 238 shipments of Idaho Nuclear Technology and Engineering Center glass form waste, 20 shipments of Argonne National Laboratory-West ceramic form waste, and 2 shipments of Argonne National Laboratory-West metallic form waste (see Appendix A, Section A.2.3.5.1).
f. High-level radioactive waste at West Valley is commercial rather than DOE waste.

### J.1.2.1.3 *Greater-Than-Class-C and Special-Performance-Assessment-Required Waste Shipments*

Reasonably foreseeable future actions could include shipment of Greater-Than-Class-C and Special-Performance-Assessment-Required waste to the Yucca Mountain Repository (Appendix A describes Greater-Than-Class-C and Special-Performance-Assessment-Required wastes). Commercial nuclear powerplants, research reactors, radioisotope manufacturers, and other manufacturing and research institutions generate low-level radioactive waste that exceeds the Nuclear Regulatory Commission Class C shallow-land-burial disposal limits. In addition to DOE-held material, there are three other sources or categories of Greater-Than-Class-C low-level radioactive waste:

- Nuclear utilities
- Sealed sources
- Other generators

The activities of nuclear electric utilities and other radioactive waste generators to date have produced relatively small quantities of Greater-Than-Class-C low-level radioactive waste. As the utilities take their reactors out of service and decommission them, they could generate more waste of this type.

DOE Special-Performance-Assessment-Required low-level radioactive waste could include the following materials:

- Production reactor operating wastes
- Production and research reactor decommissioning wastes
- Non-fuel-bearing components of naval reactors
- Sealed radioisotope sources that exceed Class C limits for waste classification
- DOE isotope production-related wastes
- Research reactor fuel assembly hardware

The analysis estimated the number of shipments of Greater-Than-Class-C and Special-Performance-Assessment-Required waste by assuming that 10 cubic meters (about 350 cubic feet) would be shipped in a rail cask and 2 cubic meters (about 71 cubic feet) would be shipped in a truck cask. Table J-8 lists the resulting number of commercial Greater-Than-Class-C shipments in Inventory Module 2 for both truck and rail shipments. The shipments of Greater-Than-Class-C waste from commercial utilities would originate among the commercial reactor sites. Typically, boiling-water reactors would ship a total of about 9 cubic meters (about 318 cubic feet) of Greater-Than-Class-C waste per site, while pressurized-water reactors would ship about 20 cubic meters (about 710 cubic feet) per site (see Appendix A). The impacts of transporting this waste were examined for each reactor site. The analysis assumed that sealed sources and Greater-Than-Class-C waste identified as “other” would be shipped from the DOE Savannah River Site (see Table J-8).

**Table J-8.** Commercial Greater-Than-Class-C waste shipments.[a]

| Category | Truck | Rail |
|---|---|---|
| Commercial utilities | 742 | 210 |
| Sealed sources | 121 | 25 |
| Other | 233 | 47 |
| ***Totals*** | ***1,096*** | ***282*** |

a. Source: Appendix A.

The analysis assumed DOE Special-Performance-Assessment-Required waste would be shipped from four DOE sites listed in Table J-9. Naval reactor and Argonne East Special-Performance-Assessment-Required waste is assumed to be shipped from the Idaho National Engineering and Environmental Laboratory.

**Table J-9.** DOE Special-Performance-Assessment-Required waste shipments.[a]

| Site[b] | Rail | Truck |
|---|---|---|
| Hanford | 2 | 10 |
| INEEL[c] | 58 | 66 |
| SRS (ORNL) | 294 | 1,466 |
| West Valley | 56 | 276 |
| ***Totals*** | ***410*** | ***1,763*** |

a. Source: Appendix A; rounded.
b. Abbreviations: INEEL = Idaho National Engineering and Environmental Laboratory; SRS = Savannah River Site; ORNL = Oak Ridge National Laboratory.
c. Includes 55 rail shipments of naval Special-Performance-Assessment-Required waste. These shipments would travel by rail regardless of scenario.

#### J.1.2.1.4 *Sensitivity of Transportation Impacts to Number of Shipments*

As discussed in Section J.1.2.1, the number of shipments from commercial and DOE sites to the repository would depend on the mix of legal-weight truck and rail shipments. At this time, many years before shipments could begin, it is impossible to predict the mix with a reasonable degree of accuracy. Therefore, the analysis used two scenarios to provide results that bound the range of anticipated impacts. Thus, for a mix of legal-weight truck and rail shipments within the range of the mostly legal-weight truck and mostly rail scenarios, the impacts would be likely to lie within the bounds of the impacts predicted by the analysis. For example, a mix that is different from the scenarios analyzed could consist of 10,000 legal-weight truck shipments and 8,000 rail shipments over 24 years (compared to approximately 1,100 and 9,600, respectively, for the mostly rail scenario). In this example, the number of traffic fatalities would be between 3.1 (estimated for the Proposed Action under the mostly rail scenario) and 4.5 (estimated for the mostly legal-weight truck scenario). Other examples that have different mixes within the ranges bounded by the scenarios would lead to results that would be within the range of the evaluated impacts.

In addition to mixes within the brackets, the number of shipments could fall outside the ranges used for the mostly legal-weight truck and rail transportation scenarios. If, for example, the mostly rail scenario used smaller rail casks than the analysis assumed, the number of shipments would be greater. If spent nuclear fuel was placed in the canisters before they were shipped, the added weight and size of the canisters would reduce the number of fuel assemblies that a given cask could accommodate; this would increase the number of shipments. However, for the mostly rail scenario, even if the capacity of the casks was half that used in the analysis, the impacts would remain below those forecast for the mostly legal-weight truck scenario. Although impacts would be related to the number of shipments, because the number of rail shipments would be very small in comparison to the total railcar traffic on the Nation’s railroads, increases or decreases would be small for impacts to biological resources, air quality, hydrology, noise, and other environmental resource areas. Thus, the impacts of using smaller rail casks would be covered by the values estimated in this EIS.

For legal-weight truck shipments, the use of casks carrying smaller payloads than those used in the analysis (assuming the shipment of the same spent nuclear fuel) would lead to larger impacts for incident-free transportation and traffic fatalities and about the same level of radiological accident risk. The relationship is approximately linear; if the payloads of truck shipping casks in the mostly legal-weight truck scenario were less by one-half, the incident-free impacts would increase by approximately a factor of 2. Conversely, because the amount of radioactive material in a cask would be less (assuming shipment of the same spent nuclear fuel), the radiological consequences of maximum reasonably foreseeable accident scenarios would be less with the use of smaller casks. If smaller casks were used to accommodate shipments of spent nuclear fuel with shorter cooling time and higher burnup, the radiological consequences of maximum reasonably foreseeable accident scenarios would be about the same.

### J.1.2.2 Transportation Routes

At this time, about 10 years before shipments could begin, DOE has not determined the specific routes it would use to ship spent nuclear fuel and high-level radioactive waste to the proposed repository. Nonetheless, this analysis used current regulations governing highway shipments and historic rail industry practices to select existing highway and rail routes to estimate potential environmental impacts of national transportation. Routing for shipments of spent nuclear fuel and high-level radioactive waste to the proposed repository would comply with applicable regulations of the U.S. Department of Transportation and the Nuclear Regulatory Commission in effect at the time the shipments occurred, as stated in the proposed DOE revised policy and procedures (DIRS 104741-DOE 1998, all) for implementing Section 180(c) of the Nuclear Waste Policy Act, as amended (NWPA).

Approximately 4 years before shipments to the proposed repository began, the Office of Civilian Radioactive Waste Management plans to identify the preliminary routes that DOE anticipates using in state and tribal jurisdictions so it can notify governors and tribal leaders of their eligibility for assistance under the provisions of Section 180(c) of the NWPA. DOE has published a revised proposed policy statement that sets forth its revised plan for implementing a program of technical and financial assistance to states and Native American tribes for training public safety officials of appropriate units of local government and tribes through whose jurisdictions the Department plans to transport spent nuclear fuel or high-level radioactive waste (63 *FR* 23756, January 2, 1998) (see Appendix M, Section M.8).

The analysis of impacts of the Proposed Action and Modules 1 and 2 used characteristics of routes that shipments of spent nuclear fuel and high-level radioactive waste could travel from the originating sites listed in Tables J-4 through J-7. Existing routes that could be used were identified for the mostly legal-weight truck and mostly rail transportation scenarios and included the 10 rail and heavy-haul truck implementing alternatives evaluated in the EIS for transportation in Nevada. The route characteristics used were the transportation mode (highway, railroad, or navigable waterway) and, for each of the modes, the total distance between an originating site and the repository. In addition, the analysis estimated the fraction of travel that would occur in rural, suburban, and urban areas for each route. The fraction of travel in each population zone was determined using 1990 Census data (see Section J.1.1.2 and J.1.1.3) to identify population-zone impacts for route segments. The highway routes were selected for the analysis using the HIGHWAY computer program and routing requirements of the U.S. Department of Transportation for shipments of Highway Route-Controlled Quantities of Radioactive Materials (49 CFR 397.101). Shipments of spent nuclear fuel and high-level radioactive waste would contain Highway Route-Controlled Quantities of Radioactive Materials.

#### J.1.2.2.1 *Routes Used in the Analysis*

Routes used in the analysis of transportation impacts of the Proposed Action and Inventory Modules 1 and 2 are highways and rail lines that DOE anticipates it could use for legal-weight truck or rail shipments from each origin to Nevada. For rail shipments that would originate at sites not served by railroads, routes used for analysis include highway routes for heavy-haul trucks or barge routes from the sites to railheads. Figures J-5 and J-6 show the truck and rail routes, respectively, analyzed for the Proposed Action and Inventory Modules 1 and 2. Tables J-10 and J-11 list the lengths of trips and the distances of the highway and rail routes, respectively, in rural, suburban, and urban population zones. Sites that would be capable of loading rail casks, but that do not have direct rail access, are listed in Table J-11. The analysis used six ending rail nodes in Nevada (Beowawe, Caliente, Dry Lake, Eccles,

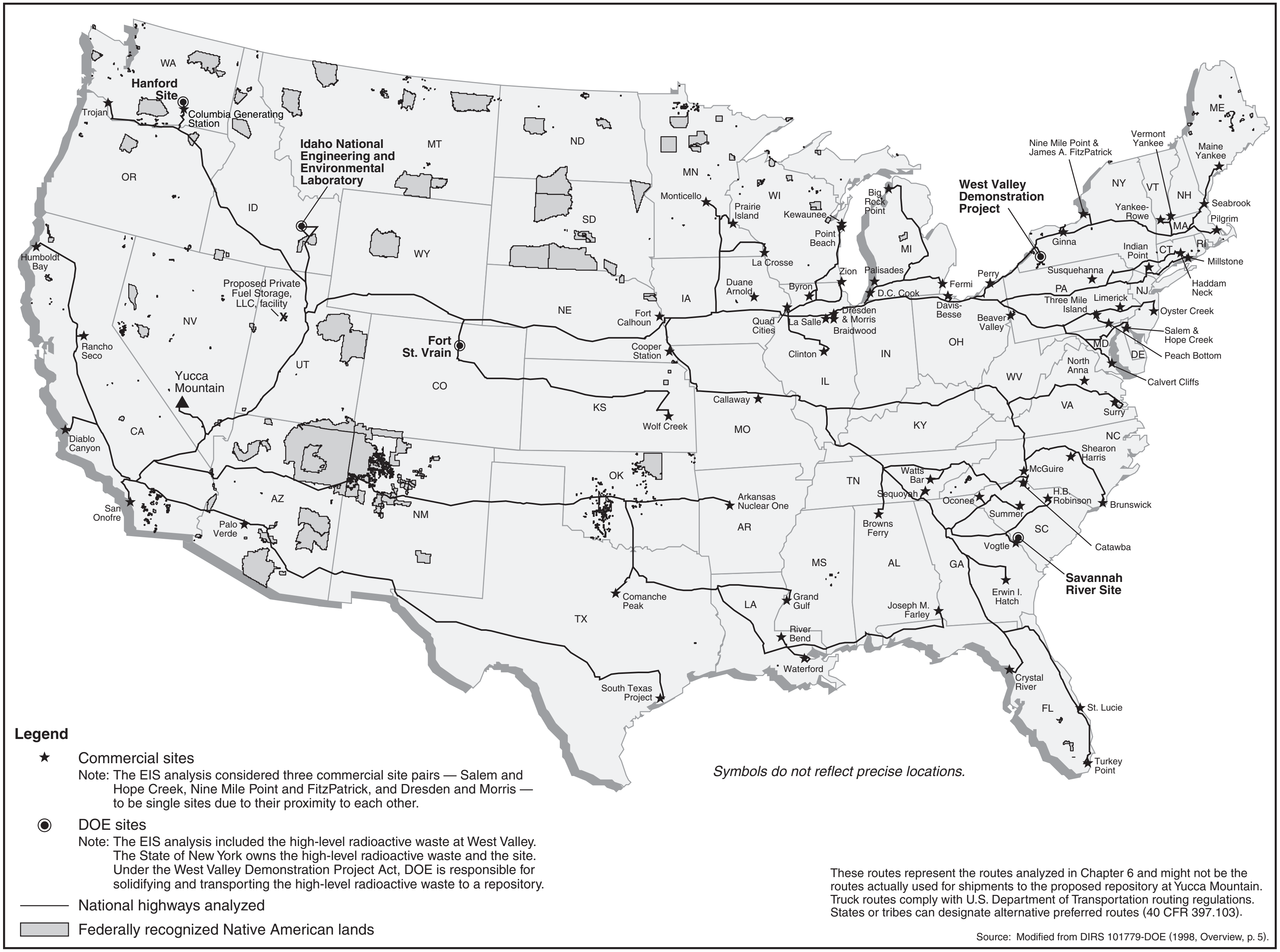


**Figure J-5.** Representative truck routes from commercial and DOE sites to Yucca Mountain analyzed for the Proposed Action and Inventory Modules 1 and 2.

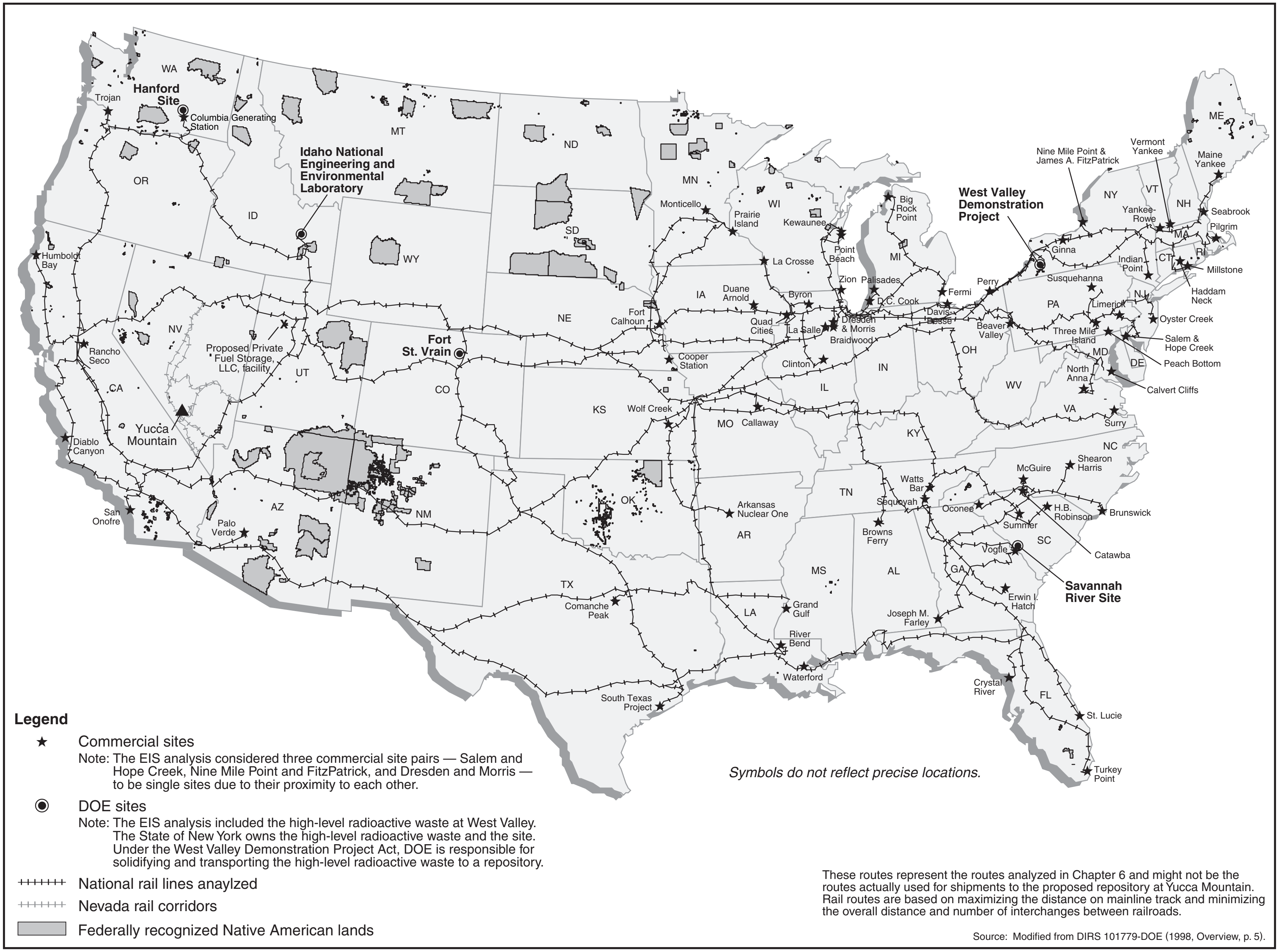


**Figure J-6.** Representative rail routes from commercial and DOE sites to Yucca Mountain analyzed for the Proposed Action and Inventory Modules 1 and 2.

**Table J-10.** Highway distances for legal-weight truck shipments from commercial and DOE sites to Yucca Mountain, mostly legal-weight truck transportation (kilometers)[a,b] (page 1 of 2).

| Origin | State | Total[c] | Rural | Suburban | Urban |
|---|---|---|---|---|---|
| Browns Ferry | AL | 3,798 | 3,344 | 393 | 61 |
| Joseph M. Farley | AL | 4,149 | 3,617 | 463 | 69 |
| Arkansas Nuclear One | AR | 2,810 | 2,588 | 191 | 30 |
| Palo Verde | AZ | 1,007 | 886 | 100 | 21 |
| Diablo Canyon | CA | 1,015 | 828 | 119 | 68 |
| Humboldt Bay | CA | 1,749 | 1,465 | 192 | 92 |
| Rancho Seco | CA | 1,228 | 1,028 | 124 | 76 |
| San Onofre | CA | 694 | 517 | 89 | 87 |
| Haddam Neck | CT | 4,519 | 3,708 | 736 | 75 |
| Millstone | CT | 4,527 | 3,673 | 746 | 109 |
| Crystal River | FL | 4,675 | 3,928 | 672 | 75 |
| St. Lucie | FL | 4,944 | 4,115 | 748 | 80 |
| Turkey Point | FL | 5,198 | 4,210 | 840 | 148 |
| Edwin I. Hatch | GA | 4,342 | 3,695 | 572 | 74 |
| Vogtle | GA | 4,294 | 3,623 | 592 | 79 |
| Duane Arnold | IA | 2,773 | 2,544 | 189 | 40 |
| Braidwood | IL | 3,063 | 2,796 | 231 | 36 |
| Byron | IL | 3,032 | 2,773 | 223 | 36 |
| Clinton | IL | 3,104 | 2,814 | 252 | 38 |
| Dresden/Morris | IL | 3,059 | 2,798 | 225 | 36 |
| La Salle | IL | 3,017 | 2,766 | 215 | 36 |
| Quad Cities | IL | 2,877 | 2,631 | 211 | 36 |
| Zion | IL | 3,167 | 2,834 | 284 | 50 |
| Wolf Creek | KS | 2,686 | 2,474 | 173 | 38 |
| River Bend | LA | 3,479 | 3,097 | 322 | 60 |
| Waterford | LA | 3,565 | 3,159 | 346 | 59 |
| Pilgrim | MA | 4,722 | 3,697 | 930 | 94 |
| Yankee-Rowe | MA | 4,615 | 3,692 | 831 | 92 |
| Calvert Cliffs | MD | 4,278 | 3,511 | 684 | 82 |
| Maine Yankee | ME | 4,894 | 3,733 | 1,052 | 108 |
| Big Rock Point | MI | 3,866 | 3,266 | 547 | 52 |
| D. C. Cook | MI | 3,196 | 2,827 | 318 | 51 |
| Fermi | MI | 3,524 | 3,014 | 449 | 61 |
| Palisades | MI | 3,244 | 2,855 | 338 | 51 |
| Monticello | MN | 3,003 | 2,702 | 261 | 41 |
| Prairie Island | MN | 2,993 | 2,720 | 232 | 41 |
| Callaway | MO | 2,988 | 2,721 | 225 | 43 |
| Grand Gulf | MS | 3,354 | 2,989 | 311 | 54 |
| Brunswick | NC | 4,773 | 3,994 | 696 | 82 |
| Shearon Harris | NC | 4,543 | 3,815 | 649 | 79 |
| McGuire | NC | 4,347 | 3,737 | 535 | 74 |
| Cooper Station | NE | 2,523 | 2,328 | 160 | 36 |
| Fort Calhoun | NE | 2,348 | 2,165 | 148 | 35 |
| Seabrook | NH | 4,725 | 3,675 | 942 | 107 |
| Oyster Creek | NJ | 4,424 | 3,530 | 825 | 69 |
| Salem/Hope Creek | NJ | 4,350 | 3,531 | 739 | 79 |
| Ginna | NY | 4,089 | 3,356 | 642 | 91 |
| Indian Point | NY | 4,382 | 3,695 | 620 | 67 |
| James A. FitzPatrick/ Nine Mile Point | NY | 4,234 | 3,461 | 688 | 85 |

**Table J-10.** Highway distances for legal-weight truck shipments from commercial and DOE sites to Yucca Mountain, mostly legal-weight truck transportation (kilometers)[a,b] (page 2 of 2).

| Origin | State | Total[c] | Rural | Suburban | Urban |
|---|---|---|---|---|---|
| Davis-Besse | OH | 3,520 | 3,106 | 358 | 55 |
| Perry | OH | 3,693 | 3,157 | 464 | 73 |
| Trojan | OR | 2,137 | 1,865 | 236 | 36 |
| Beaver Valley | PA | 3,779 | 3,214 | 500 | 64 |
| Limerick | PA | 4,287 | 3,484 | 741 | 62 |
| Peach Bottom | PA | 4,205 | 3,479 | 662 | 63 |
| Susquehanna | PA | 4,126 | 3,539 | 528 | 59 |
| Three Mile Island | PA | 4,147 | 3,443 | 643 | 60 |
| Catawba | SC | 4,350 | 3,686 | 594 | 70 |
| Oconee | SC | 4,208 | 3,586 | 551 | 71 |
| H. B. Robinson | SC | 4,467 | 3,739 | 647 | 81 |
| Summer | SC | 4,352 | 3,704 | 576 | 71 |
| Sequoyah | TN | 3,856 | 3,361 | 433 | 61 |
| Watts Bar | TN | 3,933 | 3,460 | 413 | 61 |
| Comanche Peak | TX | 2,794 | 2,547 | 213 | 34 |
| South Texas | TX | 3,011 | 2,652 | 295 | 64 |
| North Anna | VA | 4,437 | 3,825 | 533 | 79 |
| Surry | VA | 4,611 | 3,898 | 629 | 83 |
| Vermont Yankee | VT | 4,615 | 3,675 | 846 | 94 |
| Colombia Generating Station | WA | 1,880 | 1,669 | 178 | 32 |
| Kewaunee | WI | 3,347 | 2,978 | 314 | 55 |
| La Crosse | WI | 3,014 | 2,773 | 198 | 43 |
| Point Beach | WI | 3,341 | 2,972 | 314 | 55 |
| Ft. St. Vrain[d] | CO | 1,637 | 1,501 | 108 | 28 |
| INEEL[e] | ID | 1,201 | 1,044 | 129 | 27 |
| West Valley[f] | NY | 3,959 | 3,322 | 562 | 75 |
| Savannah River[e] | SC | 4,294 | 3,622 | 593 | 79 |
| Hanford[e] | WA | 1,881 | 1,671 | 178 | 32 |

a. To convert kilometers to miles, multiply by 0.62137.
b. Distances determined for purposes of analysis using HIGHWAY computer program.
c. Totals might differ from sums due to method of calculation and rounding.
d. DOE spent nuclear fuel site.
e. DOE spent nuclear fuel and high-level radioactive waste site.
f. High-level radioactive waste site.

Jean, and Apex) to select rail routes from the 77 sites. These rail nodes would be starting points for the rail and heavy-haul truck implementing alternatives analyzed for transportation in Nevada.

*Selection of Highway Routes.* The analysis of national transportation impacts used route characteristics of existing highways, such as distances, population densities, and state-level accident statistics. The analysis of highway shipments of spent nuclear fuel and high-level radioactive waste used the HIGHWAY computer model (DIRS 104780-Johnson et al. 1993, all) to determine highway routes using regulations of the U.S. Department of Transportation (49 CFR 397.101) that specify how routes are selected. The selection of "preferred routes" is required for shipment of these materials. DOE has determined that the HIGHWAY program is appropriate for calculating highway routes and related information (DIRS 101845-Maheras and Pippen 1995, pp. 2 to 5). HIGHWAY is a routing tool that DOE has used in previous EISs [for example, the programmatic EIS on spent nuclear fuel (DIRS 101802-DOE 1995, Volume 1, p. I-6) and the Waste Isolation Pilot Plant Supplement II EIS (DIRS 101814-DOE 1997, pp. 5 to 13)] to determine highway routes for impact analysis.

**Table J-11.** Rail transportation distances from commercial and DOE sites to Nevada ending rail nodes[a] (kilometers)[b,c] (page 1 of 3).

| Site | Total[d] | Rural | Suburban | Urban |
|---|---|---|---|---|
| *Commercial sites with direct rail access* | | | | |
| Arkansas Nuclear One | 2,593 - 2,930 | 2,427 - 2,720 | 149 - 181 | 17 - 29 |
| Beaver Valley | 3,242 - 3,579 | 2,675 - 2,968 | 452 - 484 | 115 - 127 |
| Braidwood | 2,586 - 2,923 | 2,260 - 2,553 | 253 - 286 | 73 - 85 |
| Brunswick | 4,145 - 4,482 | 3,363 - 3,656 | 721 - 753 | 60 - 72 |
| Byron | 2,403 - 2,740 | 2,207 - 2,500 | 172 - 204 | 24 - 35 |
| Catawba | 3,819 - 4,156 | 3,265 - 3,559 | 495 - 527 | 59 - 70 |
| Clinton | 2,595 - 2,932 | 2,358 - 2,651 | 196 - 228 | 41 - 53 |
| Columbia Generating Station | 1,369 - 1,706 | 1,274 - 1,567 | 84 - 116 | 11 - 22 |
| Comanche Peak | 2,492 - 2,678 | 2,218 - 2,401 | 213 - 236 | 37 - 43 |
| Crystal River | 4,175 - 4,653 | 3,481 - 3,960 | 587 - 672 | 55 - 106 |
| D. C. Cook | 2,632 - 2,969 | 2,261 - 2,555 | 277 - 309 | 94 - 105 |
| Davis Besse | 2,917 - 3,254 | 2,452 - 2,745 | 356 - 389 | 109 - 121 |
| Dresden/Morris | 2,510 - 2,847 | 2,253 - 2,546 | 222 - 255 | 35 - 46 |
| Duane Arnold | 2,168 - 2,505 | 2,014 - 2,307 | 135 - 167 | 20 - 31 |
| Edwin I. Hatch | 3,929 - 4,266 | 3,396 - 3,689 | 480 - 513 | 53 - 64 |
| Fermi | 3,072 - 3,409 | 2,513 - 2,806 | 437 - 469 | 123 - 135 |
| H. B. Robinson | 3,889 - 4,226 | 3,137 - 3,430 | 685 - 717 | 68 - 79 |
| Humboldt Bay | 724 - 1,412 | 550 - 1,093 | 137 - 239 | 36 - 80 |
| James A. FitzPatrick/Nine Mile Point | 3,632 - 3,969 | 2,848 - 3,141 | 631 - 663 | 154 - 165 |
| Joseph M. Farley | 4,021 - 4,358 | 3,438 - 3,731 | 529 - 561 | 54 - 66 |
| La Crosse | 2,851 - 3,579 | 2,578 - 3,361 | 196 - 234 | 22 - 39 |
| La Salle | 2,653 - 3,381 | 2,396 - 3,179 | 181 - 220 | 20 - 37 |
| Limerick | 3,934 - 4,271 | 3,148 - 3,441 | 664 - 696 | 123 - 135 |
| Maine Yankee | 4,435 - 4,771 | 3,245 - 3,538 | 1,008 - 1,040 | 182 - 193 |
| McGuire | 3,916 - 4,253 | 3,170 - 3,463 | 679 - 712 | 66 - 78 |
| Millstone | 4,139 - 4,476 | 3,078 - 3,371 | 893 - 925 | 168 - 179 |
| Monticello | 2,655 - 2,822 | 2,347 - 2,543 | 241 - 265 | 38 - 44 |
| North Anna | 3,944 - 4,281 | 3,132 - 3,425 | 639 - 672 | 172 - 184 |
| Palo Verde | 872 - 1,466 | 778 - 1,113 | 77 - 252 | 18 - 101 |
| Perry | 3,222 - 3,558 | 2,836 - 3,129 | 317 - 349 | 69 - 80 |
| Prairie Island | 2,344 - 2,681 | 2,100 - 2,393 | 223 - 255 | 22 - 33 |
| Quad Cities | 2,595 - 3,323 | 2,324 - 3,108 | 194 - 233 | 21 - 38 |
| Rancho Seco | 263 - 882 | 178 - 694 | 61 - 139 | 24 - 48 |
| River Bend | 3,266 - 3,405 | 2,966 - 3,027 | 268 - 358 | 28 - 68 |
| San Onofre | 472 - 1,133 | 322 - 756 | 93 - 264 | 58 - 112 |
| Seabrook | 4,282 - 4,619 | 3,183 - 3,477 | 920 - 952 | 179 - 190 |
| Sequoyah | 3,366 - 3,703 | 3,044 - 3,337 | 277 - 309 | 46 - 57 |
| Shearon Harris | 4,046 - 4,383 | 3,301 - 3,595 | 686 - 718 | 59 - 70 |
| South Texas | 2,815 - 3,277 | 2,539 - 2,770 | 234 - 434 | 42 - 73 |
| Summer | 3,755 - 4,092 | 3,291 - 3,584 | 414 - 446 | 50 - 62 |
| Susquehanna | 3,827 - 4,164 | 2,883 - 3,176 | 771 - 803 | 173 - 185 |
| Three Mile Island | 3,828 - 4,165 | 3,129 - 3,422 | 588 - 620 | 111 - 123 |
| Trojan | 1,326 - 2,048 | 1,040 - 1,836 | 172 - 346 | 40 - 108 |
| Vermont Yankee | 4,078 - 4,415 | 3,135 - 3,429 | 778 - 811 | 164 - 176 |
| Vogtle | 3,985 - 4,322 | 3,443 - 3,736 | 489 - 522 | 53 - 64 |
| Waterford | 3,408 - 3,540 | 2,878 - 3,086 | 293 - 453 | 63 - 76 |
| Watts Bar | 3,310 - 3,647 | 3,011 - 3,304 | 254 - 286 | 46 - 57 |
| Wolf Creek | 2,108 - 2,445 | 1,995 - 2,288 | 98 - 130 | 15 - 27 |
| Zion | 2,542 - 2,879 | 2,231 - 2,525 | 247 - 279 | 64 - 75 |

**Table J-11.** Rail transportation distances from commercial and DOE sites to Nevada ending rail nodes[a] (kilometers)[b,c] (page 2 of 3).

| Site | Total[d] | Rural | Suburban | Urban |
|---|---|---|---|---|
| *Commercial sites with indirect rail access* | | | | |
| Big Rock Point | | | | |
| HH[e]-20.0 kilometers | 3,258 - 3,595 | 2,766 - 3,059 | 399 - 431 | 93 - 105 |
| Browns Ferry | | | | |
| HH-55.4 kilometers | 3,118 - 3,455 | 2,723 - 3,016 | 353 - 386 | 42 - 53 |
| Callaway | | | | |
| HH-18.5 kilometers | 2,230 - 2,567 | 2,103 - 2,396 | 108 - 140 | 20 - 32 |
| Calvert Cliffs | | | | |
| HH-41.9 kilometers | 3,829 - 4,166 | 3,024 - 3,317 | 631 - 663 | 174 - 185 |
| Cooper Station | | | | |
| HH-53.8 kilometers | 1,852 - 2,189 | 1,719 - 2,012 | 109 - 141 | 25 - 36 |
| Diablo Canyon | | | | |
| HH-43.5 kilometers | 715 - 789 | 461 - 522 | 162 - 181 | 73 - 105 |
| Fort Calhoun | | | | |
| HH-6.0 kilometers | 1,736 - 2,073 | 1,656 - 1,949 | 70 - 102 | 10 - 21 |
| Ginna | | | | |
| HH-35.1 kilometers | 3,532 - 3,869 | 2,792 - 3,086 | 604 - 636 | 136 - 147 |
| Grand Gulf | | | | |
| HH-47.8 kilometers | 3,108 - 3,445 | 2,817 - 3,115 | 259 - 373 | 28 - 67 |
| Haddam Neck | | | | |
| HH-16.6 kilometers | 4,105 - 4,442 | 3,070 - 3,363 | 868 - 901 | 167 - 178 |
| Hope Creek | | | | |
| HH-51.0 kilometers | 3,978 - 4,315 | 2,842 - 3,135 | 912 - 944 | 225 - 236 |
| Indian Point | | | | |
| HH-14.2 kilometers | 3,981 - 4,318 | 3,034 - 3,327 | 781 - 813 | 166 - 177 |
| Kewanee | | | | |
| HH-9.7 kilometers | 2,867 - 3,204 | 2,421 - 2,714 | 363 - 395 | 84 - 95 |
| Oconee | | | | |
| HH-17.5 kilometers | 3,738 - 4,075 | 3,221 - 3,514 | 464 - 496 | 54 - 65 |
| Oyster Creek | | | | |
| HH-28.5 kilometers | 4,061 - 4,398 | 2,862 - 3,155 | 957 - 989 | 242 - 254 |
| Palisades | | | | |
| HH-41.9 kilometers | 2,680 - 3,017 | 2,279 - 2,572 | 306 - 338 | 96 - 107 |
| Peach Bottom | | | | |
| HH-58.9 kilometers | 3,849 - 4,186 | 3,134 - 3,427 | 604 - 637 | 111 - 122 |
| Pilgrim | | | | |
| HH-8.7 kilometers | 4,263 - 4,600 | 3,103 - 3,396 | 986 - 1,018 | 174 - 185 |
| Point Beach | | | | |
| HH-36.4 kilometers | 2,820 - 3,157 | 2,405 - 2,698 | 338 - 370 | 78 - 89 |
| Salem | | | | |
| HH-51.0 kilometers | 3,950 - 4,287 | 2,868 - 3,161 | 864 - 896 | 219 - 230 |
| St. Lucie | | | | |
| HH-23.5 kilometers | 4,315 - 4,840 | 3,464 - 3,984 | 732 - 809 | 74 - 125 |
| Surry | | | | |
| HH-75.2 kilometers | 4,065 - 4,402 | 3,468 - 3,761 | 523 - 555 | 74 - 85 |
| Turkey Point | | | | |
| HH-17.4 kilometers | 4,662 - 5,140 | 3,696 - 4,175 | 785 - 870 | 127 - 179 |
| Yankee-Rowe | | | | |
| HH-10.1 kilometers | 3,998 - 4,335 | 3,083 - 3,376 | 752 - 784 | 164 - 175 |

**Table J-11.** Rail transportation distances from commercial and DOE sites to Nevada ending rail nodes[a] (kilometers)[b,c] (page 3 of 3).

| Site | Total[d] | Rural | Suburban | Urban |
|---|---|---|---|---|
| *DOE spent nuclear fuel and high-level radioactive waste* | | | | |
| Ft. St. Vrain[f] | 1,039 - 1,321 | 1,011 - 1,214 | 24 - 93 | 3 - 13 |
| Hanford Site[g] | 1,356 - 1,693 | 1,262 - 1,555 | 84 - 116 | 11 - 22 |
| INEEL[g] | 482 - 819 | 445 - 738 | 34 - 66 | 4 - 15 |
| Savannah River Site[g] | 3,751 - 4,088 | 3,081 - 3,374 | 605 - 638 | 65 - 76 |
| West Valley[h] | 3,447 - 3,784 | 2,774 - 3,067 | 538 - 570 | 135 - 146 |

a. The ending rail nodes (INTERLINE computer program designations) are Apex-14763; Caliente-14770; Beowawe-14791; and Jean-16328.
b. To convert kilometers to miles, multiply by 0.62137.
c. This analysis used the INTERLINE computer program to estimate distances.
d. Totals might differ from sums due to method of calculation and rounding.
e. HH = heavy-haul truck distance.
f. DOE spent nuclear fuel.
g. DOE spent nuclear fuel and high-level radioactive waste.
h. High-level radioactive waste.

Because the regulations require that the preferred routes result in reduced time in transit, changing conditions, weather, and other factors could result in the use of more than one route at different times for shipments between the same origin and destination. However, for this analysis the program selected only one route for travel from each site to the Yucca Mountain site. Section J.4 describes the highway routes used in the analysis along with estimated impacts of legal-weight truck shipments for each state.

Although shipments could use more than one preferred route in national highway transportation to comply with U.S. Department of Transportation regulations (49 CFR 397.101), under current U.S. Department of Transportation regulations all preferred routes would ultimately enter Nevada on Interstate 15 and travel to the repository on U.S. Highway 95. States or tribes can designate alternative or additional preferred routes for highway shipments (49 CFR 397.103). At this time the State of Nevada has not identified any alternative or additional preferred routes that DOE could use for shipments to the repository.

**STATE-DESIGNATED PREFERRED ROUTES**

U.S. Department of Transportation regulations specify that states and tribes can designate preferred routes that are alternatives, or in addition to, Interstate System highways including bypasses or beltways for the transportation of Highway Route-Controlled Quantities of Radioactive Materials. Highway Route-Controlled of Radioactive Materials include spent nuclear fuel and high-level radioactive waste in quantities that would be shipped on a truck or railcar to the repository. If a state or tribe designated such a route, highway shipments of spent nuclear fuel and high-level radioactive waste would use the preferred route if (1) it was an alternative preferred route, (2) it would result in reduced time in transit, or (3) it would replace pickup or delivery routes. Fourteen states have designated alternative or additional preferred routes (65 *FR* 75771; December 4, 2000). Although Nevada has designated a State routing agency to the Department of Transportation (Nevada Revised Statutes, Chapter 408.141), the State has not yet designated alternative or preferred routes for Highway Route-Controlled Quantities of Radioactive Materials. State route designations in the future could require changes in highway routes that would be used for shipments of spent nuclear fuel and high-level radioactive waste from 77 sites to Yucca Mountain. As an example of recent changes, two states notified the U.S. Department of Transportation of state-designated preferred routes (65 *FR* 75771; December 4, 2000) near or following publication of the Draft EIS.

*Selection of Rail Routes.* Rail transportation routing of spent nuclear fuel and high-level radioactive waste shipments is not regulated by the U.S. Department of Transportation. As a consequence, the routing rules used by the INTERLINE computer program (DIRS 104781-Johnson et al. 1993, all) assumed that railroads would select routes using historic practices. DOE has determined that the INTERLINE program is appropriate for calculating routes and related information for use in transportation analyses (DIRS 101845-Maheras and Pippen 1995, pp. 2 to 5). Because the routing of rail shipments would be subject to future, possibly different practices of the involved railroads, DOE could use other rail routes. Section J.4 contains maps of the rail routes used in the analysis along with estimated impacts of rail shipments for each state.

For the 24 commercial sites that have the capability to handle and load rail casks but do not have direct rail service, DOE used the HIGHWAY computer program to identify routes for heavy-haul transportation to nearby railheads. For such routes, routing agencies in affected states would need to approve the transport and routing of overweight and overdimensional shipments.

#### J.1.2.2.2 *Routes for Shipping Rail Casks from Sites Not Served by a Railroad*

In addition to routes for legal-weight trucks and rail shipments, 24 commercial sites that are not served by a railroad, but that have the capability to load rail casks, could ship spent nuclear fuel to nearby railheads using heavy-haul trucks (see Table J-11). In addition, six of the sites that initially are legal-weight truck sites would be indirect rail sites after plant shutdown.

#### J.1.2.2.3 *Sensitivity of Analysis Results to Routing Assumptions*

Routing for shipments of spent nuclear fuel and high-level radioactive waste to the proposed repository would comply with regulations of the U.S. Department of Transportation and the Nuclear Regulatory Commission in effect at the time shipments would occur. Unless the State of Nevada designates alternative or additional preferred routes, to comply with U.S. Department of Transportation regulations all preferred routes would ultimately enter Nevada on Interstate 15 and travel to the repository on U.S. Highway 95. States can designate alternative or additional preferred routes for highway shipments. At this time the State of Nevada has not identified any alternative or additional preferred routes DOE could use for shipments to the repository. Section J.3.1.3 examines the sensitivity of transportation impacts both nationally and regionally (within Nevada) to changes in routing assumptions within Nevada.

## J.1.3 ANALYSIS OF IMPACTS FROM INCIDENT-FREE TRANSPORTATION

DOE analyzed the impacts of incident-free transportation for shipments of commercial and DOE spent nuclear fuel and DOE high-level radioactive waste that would be shipped under the Proposed Action and Inventory Modules 1 and 2 from 77 sites to the repository. The analysis estimated impacts to the public and workers and included impacts of loading shipping casks at commercial and DOE sites and other preparations for shipment as well as intermodal transfers of casks from heavy-haul trucks or barges to rail cars.

### J.1.3.1 Methods and Approach for Analysis of Impacts for Loading Operations

The analysis used methods and assessments developed for spent nuclear fuel loading operations at commercial sites to estimate radiological impacts to involved workers at commercial and DOE sites. Previously developed conceptual radiation shield designs for shipping casks (DIRS 101747-Schneider et al. 1987, Sections 4 and 5), rail and truck shipping cask dimensions, and estimated radiation dose rates at locations where workers would load and prepare casks (DIRS 104791-DOE 1992, p. 4.2) for shipment were the analysis bases for loading operations. In addition, tasks and time-motion evaluations from these studies were used to describe spent nuclear fuel handling and loading. These earlier evaluations were